Gowanus Canal CSO Facilities
Tunnel Alternative Evaluation

Gowanus Canal Community Advisory Group Briefing

January 22, 2019

Background

EPA's Gowanus Canal Superfund Site Record of Decision (ROD) requires the City to provide a total of 12 million gallons (MG) of combined sewer overflow (CSO) storage by means of two facilities:

- 8 MG tank at Nevins Street and Butler Street ("Head End Site")
- 4 MG tank at 5th Street and Second Avenue ("Owls Head Site")

DEP continues to advance the tank design and has met all EPA milestones associated with the project.

DEP has begun evaluating an alternative approach using a storage tunnel system, a technology that the agency is pursuing in the Long Term Control Plans (LTCPs) to address CSOs in Flushing Bay and Newtown Creek and that is used nationally and internationally to address CSOs and flooding.

Tank Program

Tunnel Program

Comparison of Benefits

Benefits of a Tunnel

- ✓ Increases storage capacity: 16 million gallons (4 million more than the two tanks)
- ✓ Reduces annual CSO events: RH 6 to 4; OH 4 to 0 (6 fewer than the tank program)
- ✓ Provides equivalent solids reduction
- ✓ Requires less disruption to the neighborhood during construction
- ✓ Provides more design flexibility for the public open space
- ✓ Does not require additional property acquisition
- ✓ Requires a comparable investment: $1.2B
- ✓ Has a similar implementation timeframe (completion 2030)
- ✓ Provides a scalable system, allowing for future extensions can capture even more CSO, reduce street flooding, improve neighborhood resiliency, accommodate future development & population growth

Tank Program: Still Moving Forward

Milestones

Environmental Impact Statement (EIS): **Completed** February 2018 ✓
ULURP for Head End Site: **Completed** April 2018 ✓
Head End Site Design

- Site Prep/Demo: **Completed** June 2017 ✓
- Excavation/Substructures: ***Underway*** (Due April 2019)
- Superstructure: ***Underway*** (Due September 2019)

Head End Site Property Acquisition: **Completed** October 2018 ✓

Rendering of Proposed Esplanade

Rendering of Proposed Tank Headhouse and Open Space

Leveraging Completed Work for the Tunnel Program

Much of the work completed for the tank program is directly applicable to the tunnel program:

- Environmental Impact Statement (only a Supplemental EIS is required to pivot to a tunnel program)
- ULURP for Head End site
- Head End Site Acquisition
- Facility Planning/Design:
  - Odor control strategy and design
  - Grit management strategy and design
  - Pumping station and headhouse layout and configuration
  - Flow diversion/influent structures strategy and design
  - Architectural visioning
  - Head End site prep and demo design (CP1)
  - Support of excavation (SOE) strategy (slurry wall to bedrock)

History of Soft-Ground Tunneling Technology

Soft ground comprises clay, silt, sand, gravel & mud, so cave-ins were a primary concern.

As early as 1818, engineers pioneered tunneling shields as a means to support the surrounding earth while digging a tunnel. As the soft ground material was removed, a permanent liner of concrete or iron was installed to support the tunnel.

Early soft ground tunnels include NYC’s first subway constructed in the 1860s and the Tower Subway beneath the River Thames in London, built in 1870.

Today, Tunnel Boring Machines (TBMs) combine mechanical boring and excavation with the construction of tunneling shields.

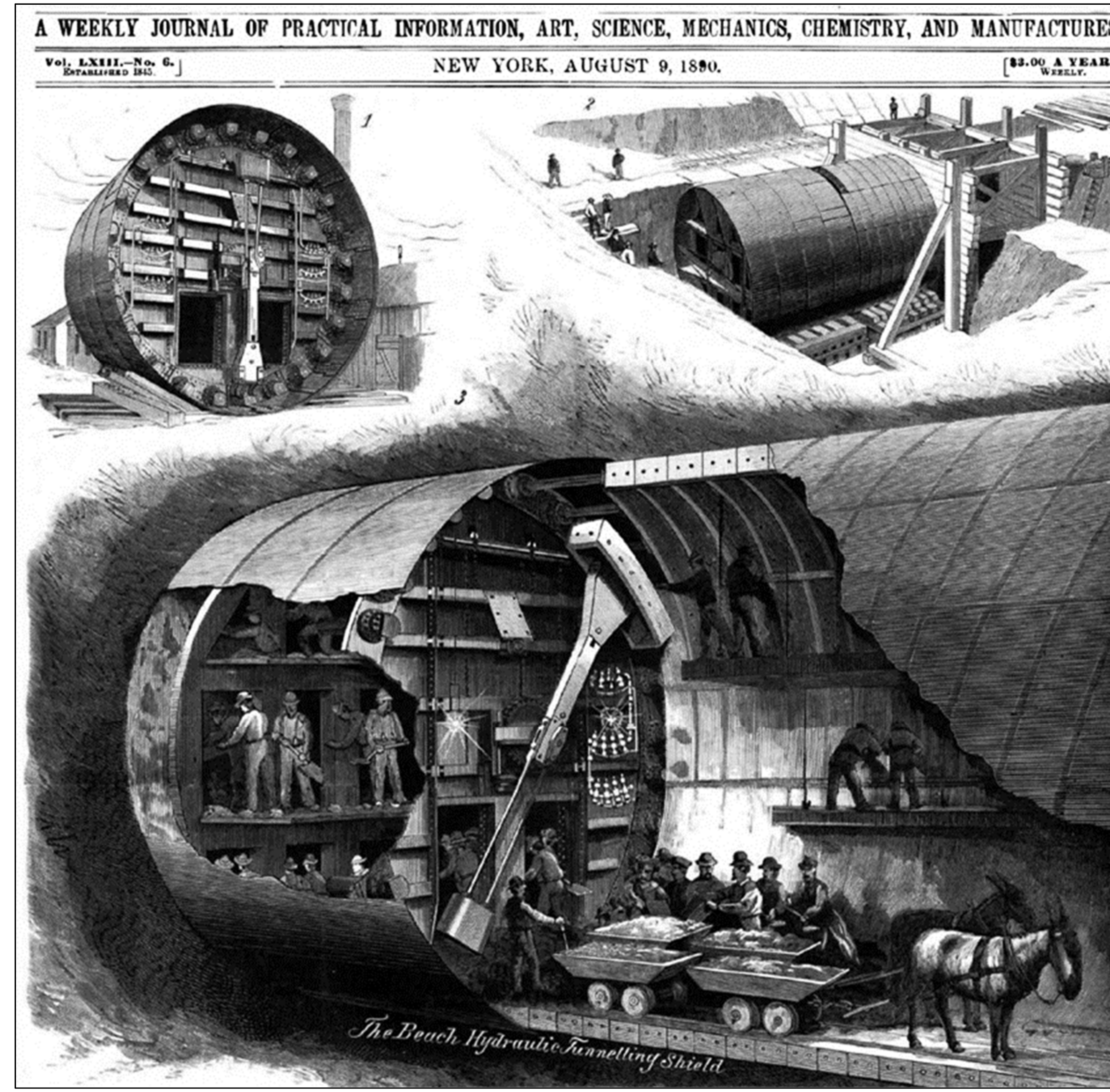
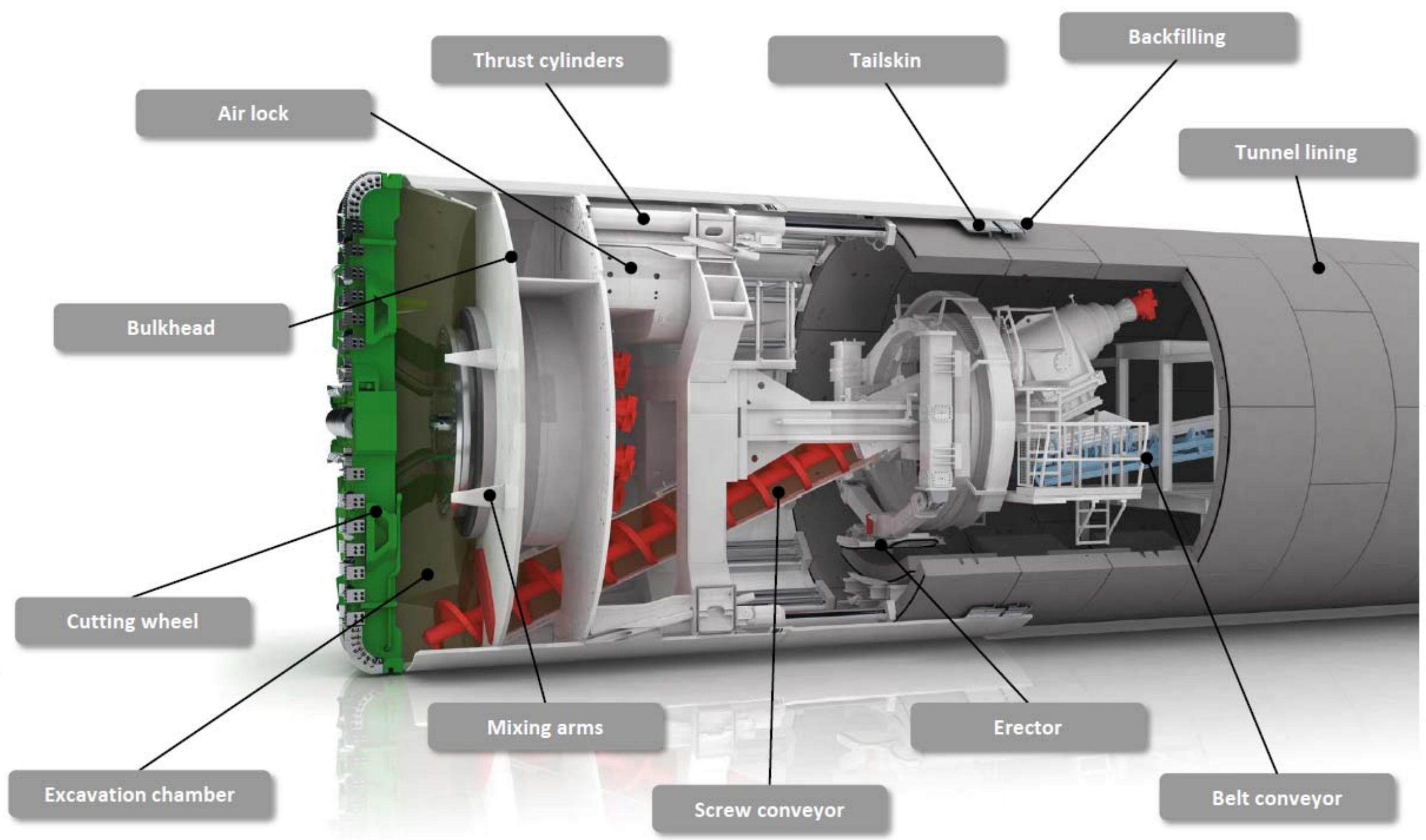
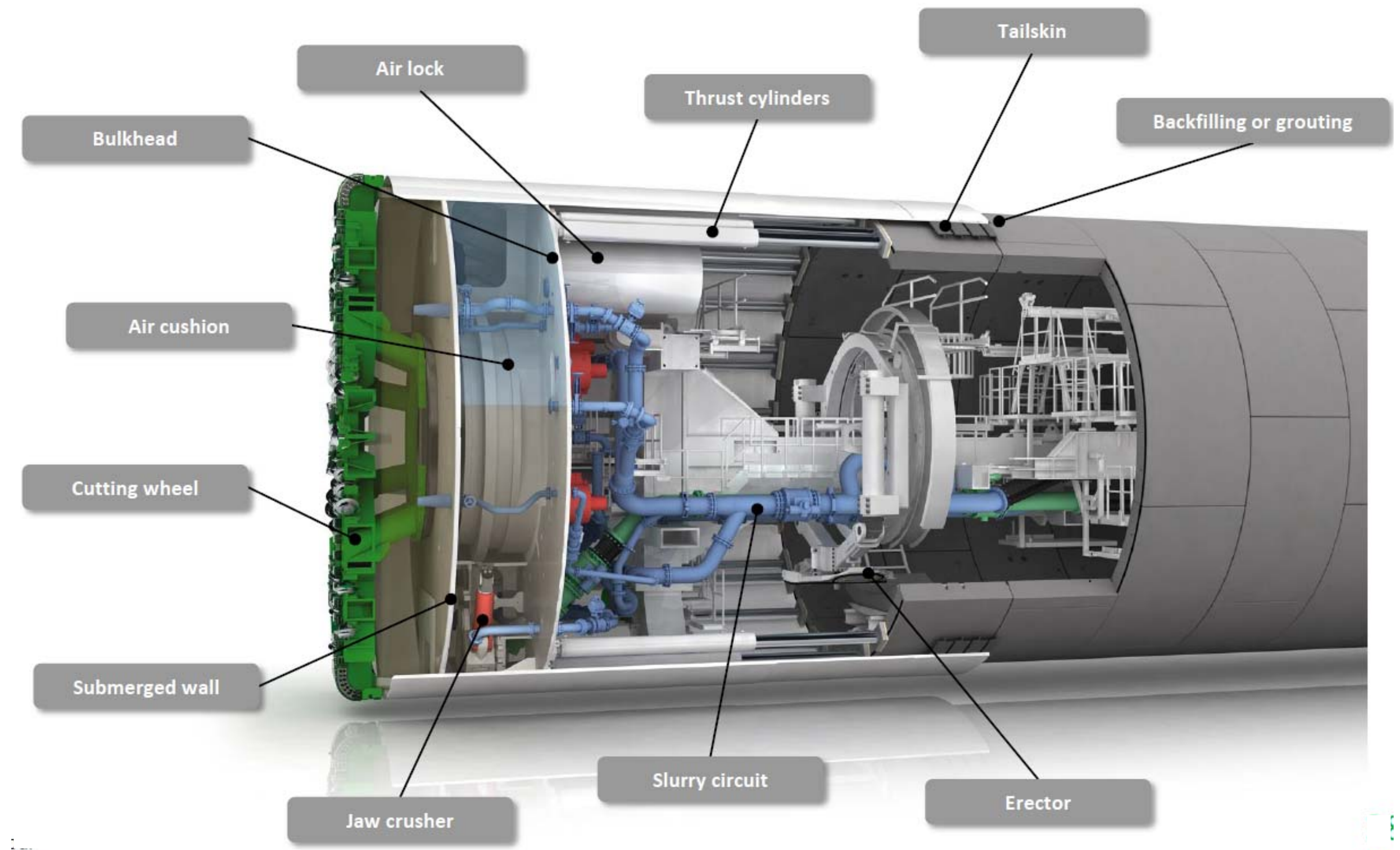


Illustration of Alfred Ely Beach’s Tunneling Shield

Tunnel Boring Machines (TBMs)



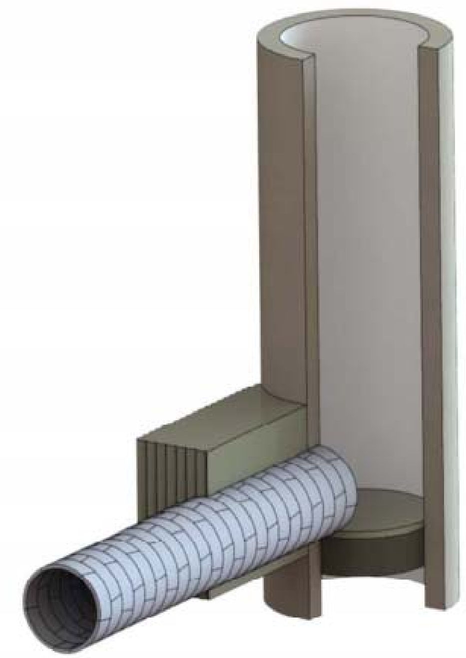
Earth Pressure Balance “EPB TBM”



Slurry Pressure Balance “Slurry TBM”/ Mixshield

Tunnel Components

Pump Station and Mining Shafts



Segmented Tunnel Shield

Slurry Wall Construction
by Hydromill Trench Cutter

Tunnel Boring Machine (TBM)

Completed Tunnel

Video: How a TBM Works

https://www.youtube.com/watch?v=MuYdnzcQXhk

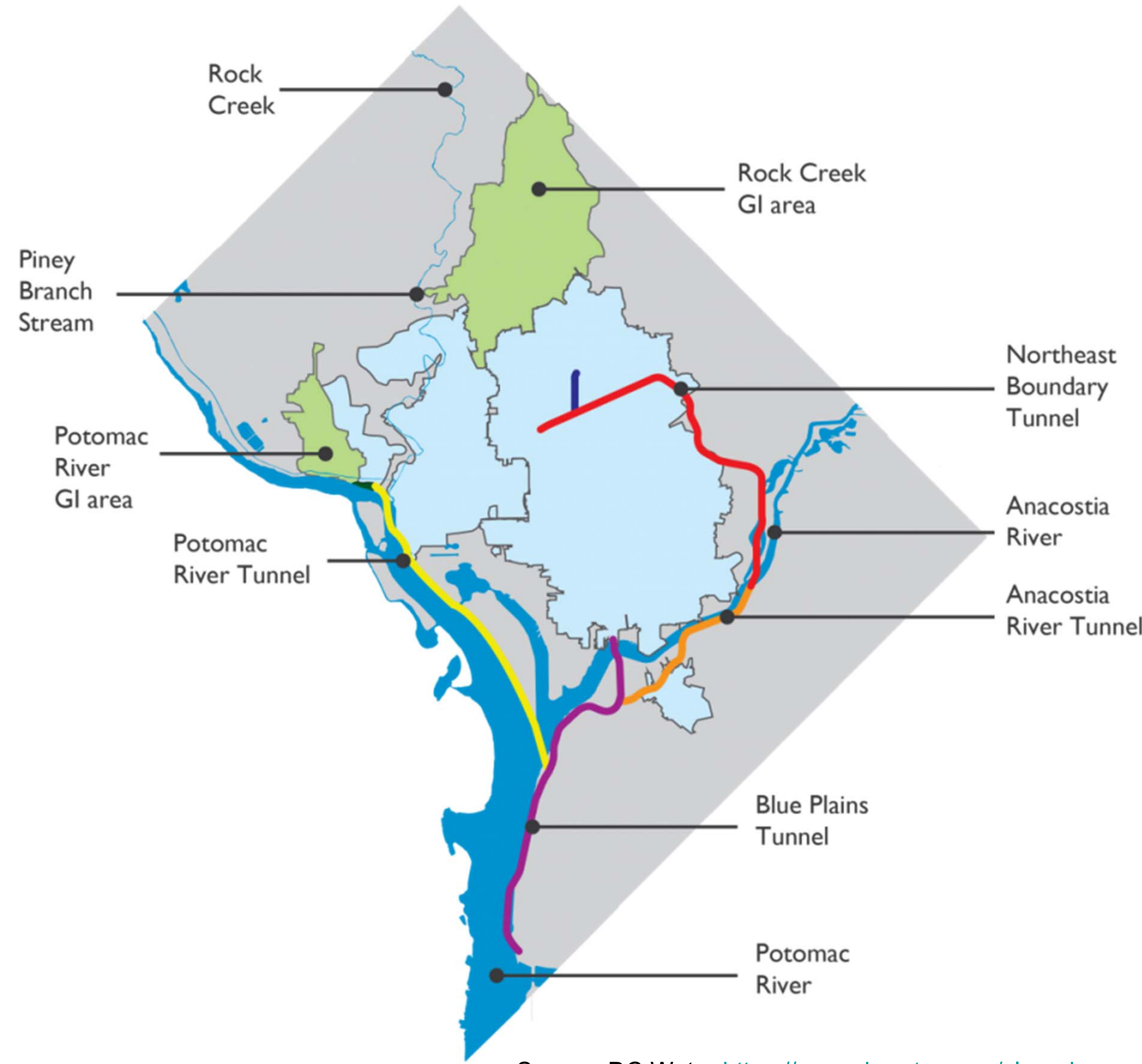
Contemporary CSO/Stormwater Tunneling Projects

Location	Project Stage	Subsurface	Length (miles)	Diameter (feet)	Storage Volume (MG)
Cleveland, OH	Design	Soft ground & rock	21	17-25	346
Washington, DC	Construction & Operation	Soft ground	18	18-23	187
London, UK	Construction	Soft ground	15.5	23.6	423
Seattle, WA	Operation	Soft ground	13	14-18	Used for conveyance
Portland, OR	Operation	Soft ground	6	22	70
Boston, MA	Operation	Soft ground	2.05	17	19
Flushing Bay, NY	Proposed	Soft ground	2.5-3.1	16-18	25
Gowanus, NY	Proposed Alternate	Soft ground	0.49	28-31	16
Rochester, NY	Operation	Rock	30	7-16	175
Milwaukee, WI	Operation	Rock	28.5	15-32	521
Indianapolis, IN	Construction	Rock	28	18	270
Hartford, CT	Construction	Rock	4.13	18	41.5
Newtown Creek, NY	Proposed	Rock	1.4-3.6	19-30	39
Providence, RI	Operation	Rock	3.08	26	64
Richmond, VA	Operation	Rock	1.14	14	7.2

Soft-Ground Tunneling Projects

NYC can benefit from decades of national and international soft-ground tunnel programs, including lessons learned and significant advances in soft-ground tunneling technology.

DEP's schedule assumptions, lessons learned, and risks have been validated primarily by recent experience with planning, design, procurement and construction of 18 miles of CSO storage and conveyance tunnels for the DC Clean Rivers project.



Source: DC Water https://www.dcwater.com/cleanrivers

Soft-Ground Tunnel: DC Clean Rivers

Tunnel Diameter: 18 to 23-ft
Tunnel Depth: 60 to 160-ft
Tunnel Length: 18 miles (combined)
Tunnel Volume: 187 MG (combined)

Construction Considerations

- Three tunnels successfully constructed (Blue Plains, Anacostia River, and First Street) and operational; one tunnel under construction (Northeast Boundary); one tunnel in planning stage (Potomac River Tunnel)
- All tunnels constructed to date using EPB TBMs through varying and challenging soft ground conditions, on land and beneath the Potomac and Anacostia rivers.
- Successful soft-ground tunneling beneath urban infrastructure including Force Mains, CSO Outfalls, Freight Rail lines, Subways, Freeways, Bridges, Levies, shoreline bulkheads, and many pile supported structures.
- Successful tunneling and surface construction adjacent to sensitive federal, municipal, private facilities and homes.
- Final tunnel structures designed and built to a 100 year design life using single-pass reinforced concrete segmental tunnel liners.

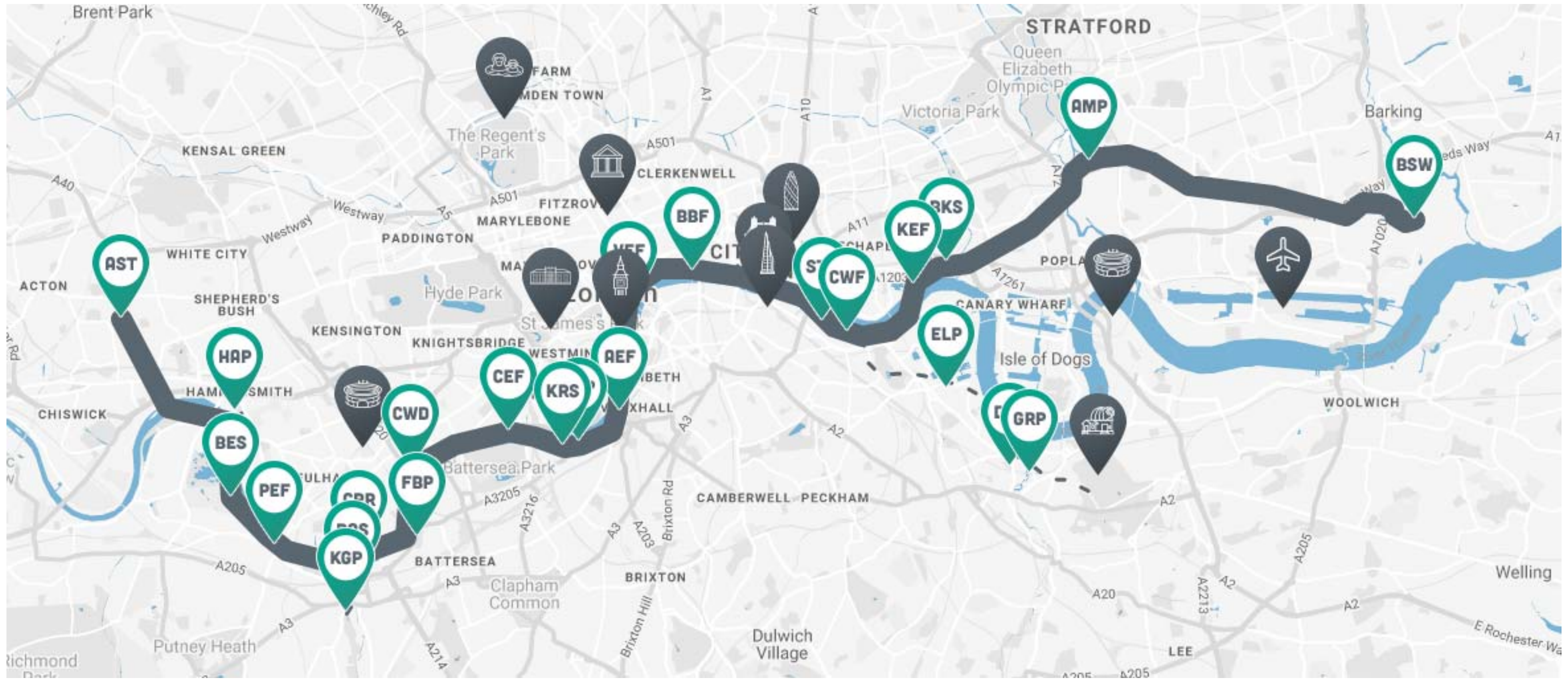
Source: DC Water https://www.dcwater.com/cleanrivers

Soft-Ground Tunnel: Thames Tideway

London, UK
Tunnel Diameter: 23.6-ft
Tunnel Depth: 66 to 213-ft
Tunnel Length: 15.5 miles
Tunnel Volume: 423 MG

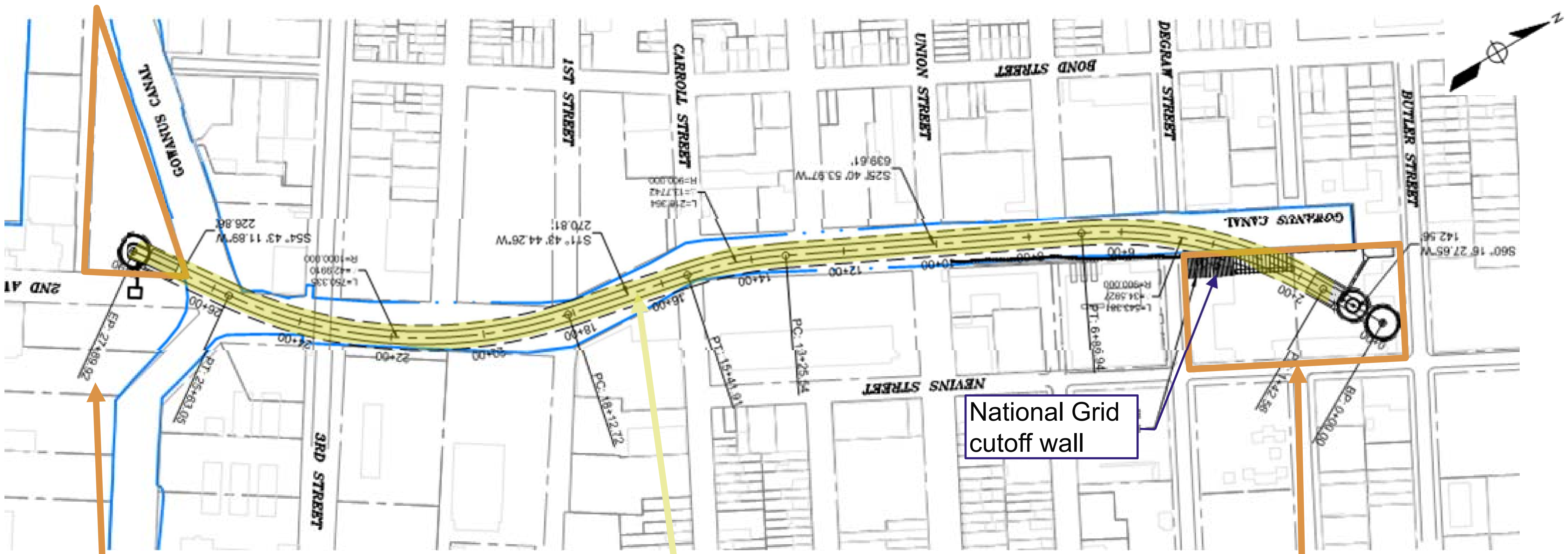
Construction Considerations

- Multi-phase program tunneling beneath land and the River Thames
- Lee Tunnel (4.3 miles) was successfully completed in 2016, and is operational. This tunnel was excavated through chalk (soft rock) using a slurry TBM.
- Thames Tideway Tunnel (15.5 miles) is currently under construction, with an anticipated completion date in 2023. Highly variable soil conditions and high water pressure along the route necessitating the use of a slurry mix-shield tunnel TBM.



Source: Tideway https://www.tideway.london/

Proposed Gowanus Tunnel Alignment

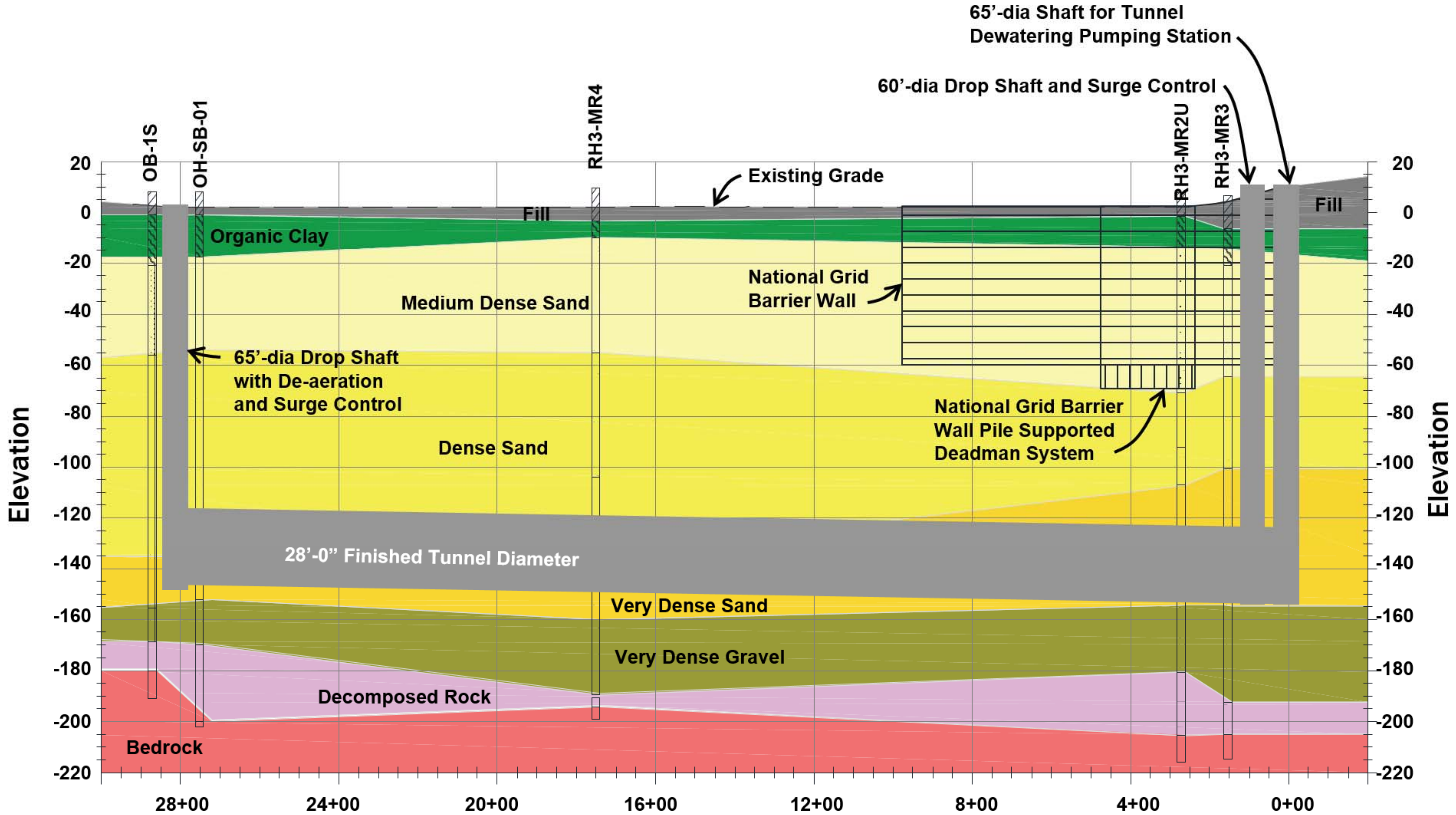


Owls Head Site Components
- 65' diameter drop shaft
- Diversion structure in 2nd Avenue
- Force main for 2nd Avenue pump station
- Headhouse for ventilation and odor control

Tunnel Alignment minimizes required easements & property acquisition

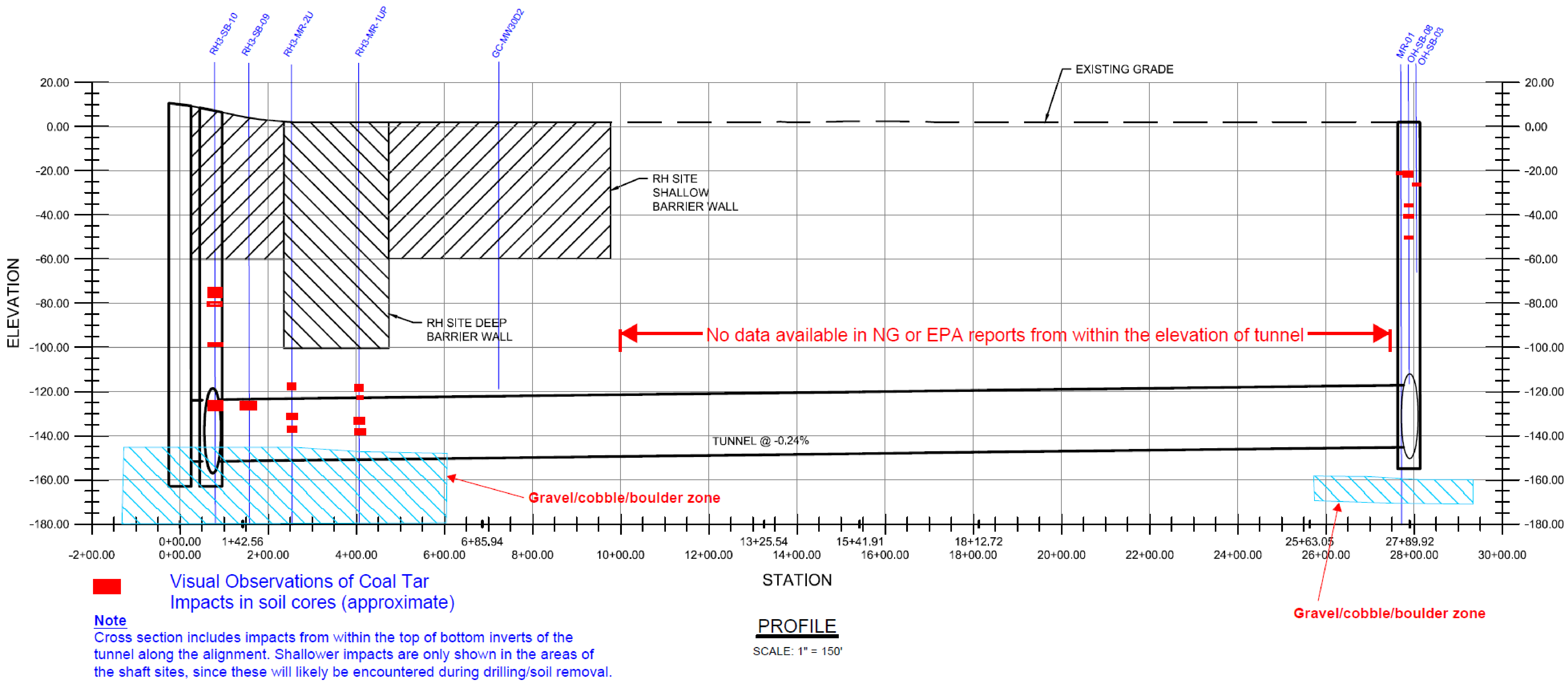
Head End Site Components
- 60' diameter drop shaft
- 65' diameter dewatering pump station shaft
- Diversion structure from outfall regulator to drop shaft
- TBM breakthrough chamber
- Headhouse for pump station, screening, grit management & odor control

Soil Profile and Proposed Gowanus Tunnel Depth



The proposed depth is driven by elevation of rock and necessary clearance below the National Grid barrier wall.

Construction Considerations: Contamination in Gowanus



Limited data available (near Head End Site) suggests that some MGP material will be encountered.

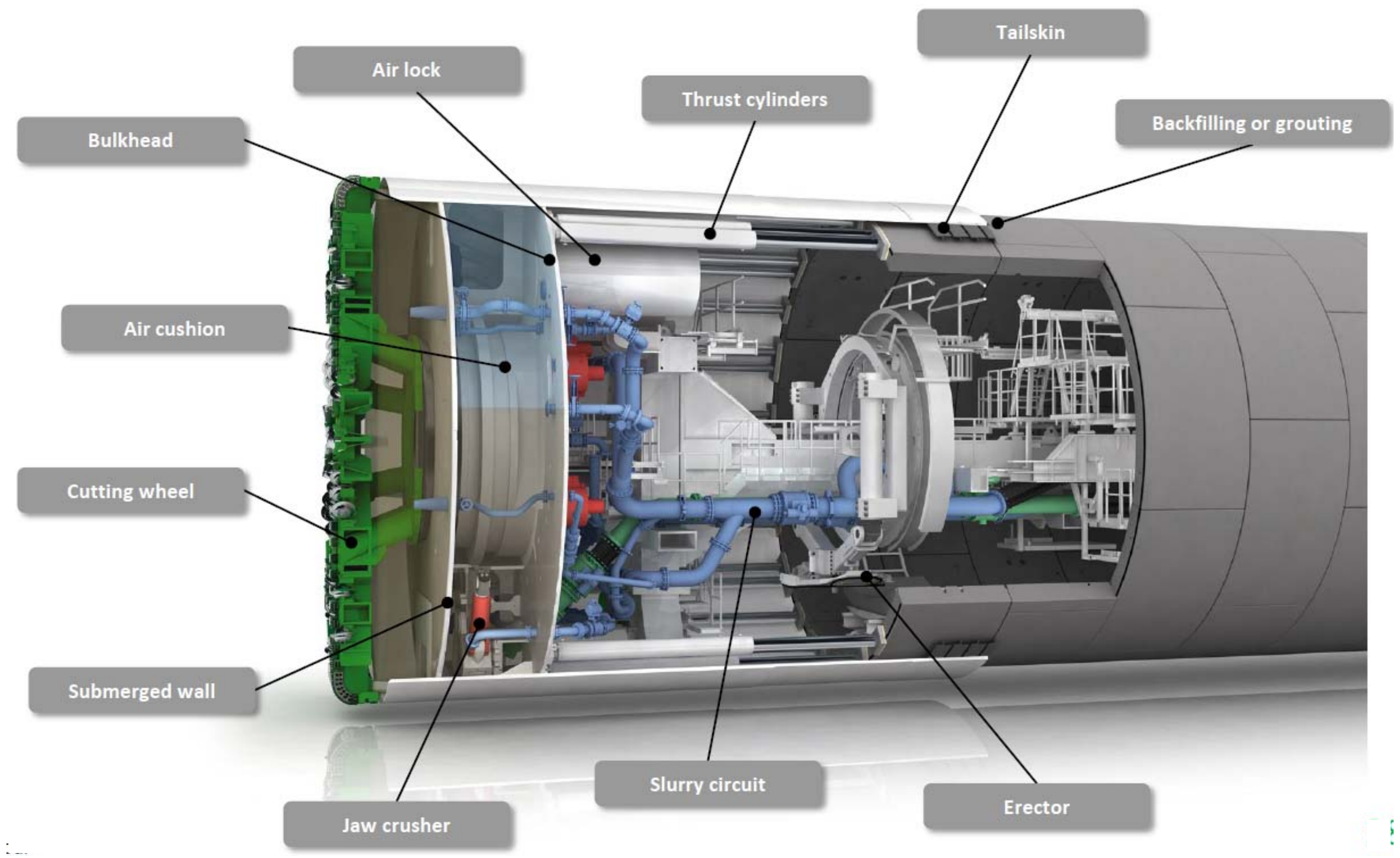
Construction Considerations: Contamination in Gowanus

DEP will conduct a significant geotech and environmental boring program as part of the future planning and design contract to better evaluate subsurface conditions and establish the environmental and geotechnical "baseline" conditions.

Composition of the soil and the extent of contamination will inform the selection and design of the tunnel boring machine (TBM).

If extensive contamination expected, a Slurry TBM system, which has a closed pipeline for the excavated material, would likely be employed.

For less extensive contamination, a traditional TBM with rail cars would be used with increased Environmental Health and Safety (EH&S) precautions for personnel.



Slurry Pressure Balance "Slurry TBM"/ Mixshield

Examples of Tunneling Projects in Contaminated Soil

NYC Environmental Protection

Project Location	Contamination Detail	Mitigation
Copenhagen, Denmark	Chlorinated compounds, including chloroform and vinyl chloride. Also included high concentrations of benzene	Retrofitted the TBM to exhaust the contaminated air, to an active-carbons air treatment facility that treated the contaminated air prior to release into the environment. Covered the screw conveyor with a duct in order to prevent the release of benzene in the groundwater. Contaminated water spillage from screw conveyor were collected and pumped/treated Belt conveyor covered with a canopy to contain the vapors and to avoid releasing into the working environment. Spray foam system on the back up discharge point.
Oakland, California	Asbestos and heavy metal	Required special handling and disposal of muck
Los Angeles, California	Contaminated ground	Special handling and disposal of muck. Increased ventilation at face used to control off-gassing and vapors when tunneling through contaminated ground.
Los Angeles, California	Methane and gas	Ventilation was improved around the screw discharge.
Los Angeles, California	Hydrogen sulfide and methane present. Tunnel alignment within or near several oil fields	TBM manufactured with an electrical system suitable for Class I, Division II as required on the project due to CalOsha "Gassy" tunnel classification.
Los Angeles, California	Adjacent to the La Brea tar pits with crude oil seeping to the surface. Chemical substances found in MGP waste, behaves in the ground similar to MGP waste.	Contaminated groundwater is treated in accordance with applicable permits prior to discharge or disposal.
Los Angeles, California	Contaminated groundwater and soil encountered during excavation.	Contractor required to maintain special procedures and precautions to separate contaminated soil from non-contaminated soil.
Los Angeles, California	Methane and hydrogen sulfide. Encountered undocumented oil fields	Provided adequate ventilation at the working face at all times during construction. 100 mil thick HDPE thick membrane installed between the temp. and perm. liner to prevent future migration of gas into tunnel.
San Francisco, California	Plume of contaminated ground and groundwater	Contaminated groundwater required treatment for VOC contamination prior to disposal into city sewer system.

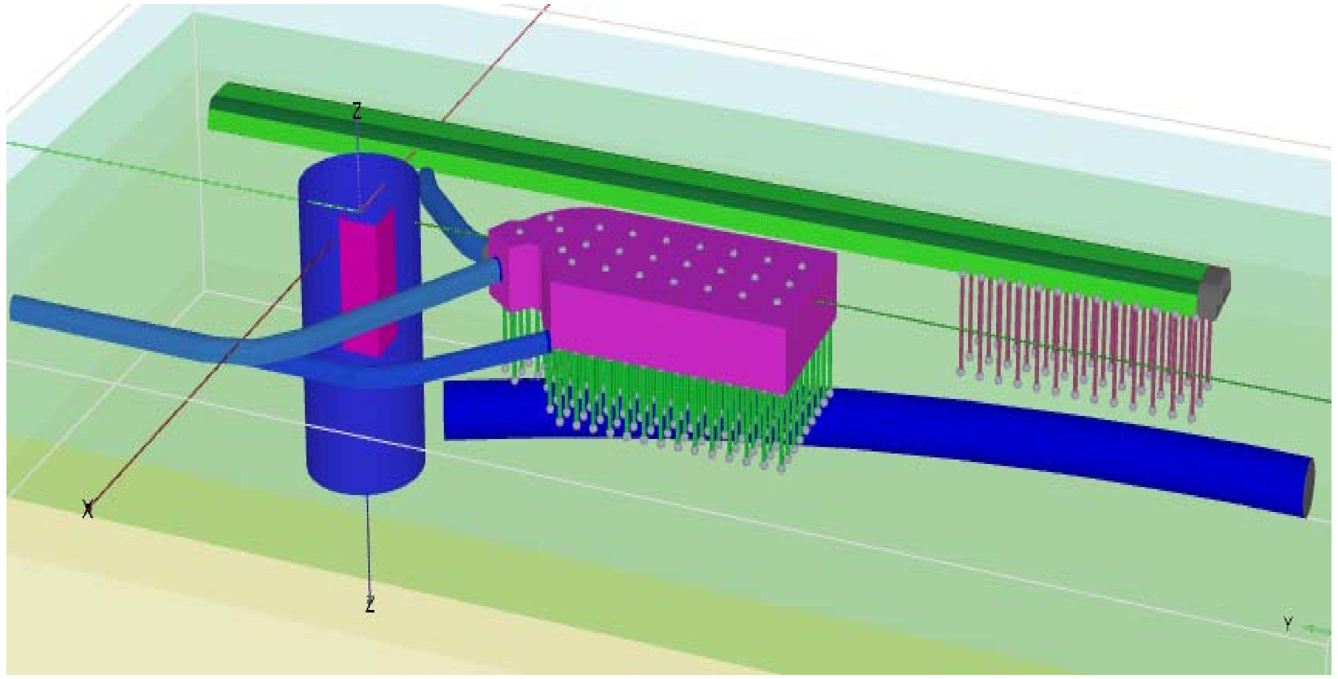
Construction Considerations: Settlement Mitigation

Modern tunneling technology (Earth Pressure Balance and Slurry TBMs) is very successful at limiting ground loss to less than 0.5% and therefore limiting ground movements

Ground losses less than 0.5% have been achieved in DC in tunnels of similar size, depth and ground conditions.

Recent successful precedent in DC and Seattle of tunneling directly beneath buildings and utilities on deep foundations.

Seattle Sound Transit Tunnels Beneath Buildings



DC Clean Rivers Tunnel Beneath Pile Foundation (Tiber Creek Sewer Outfall)

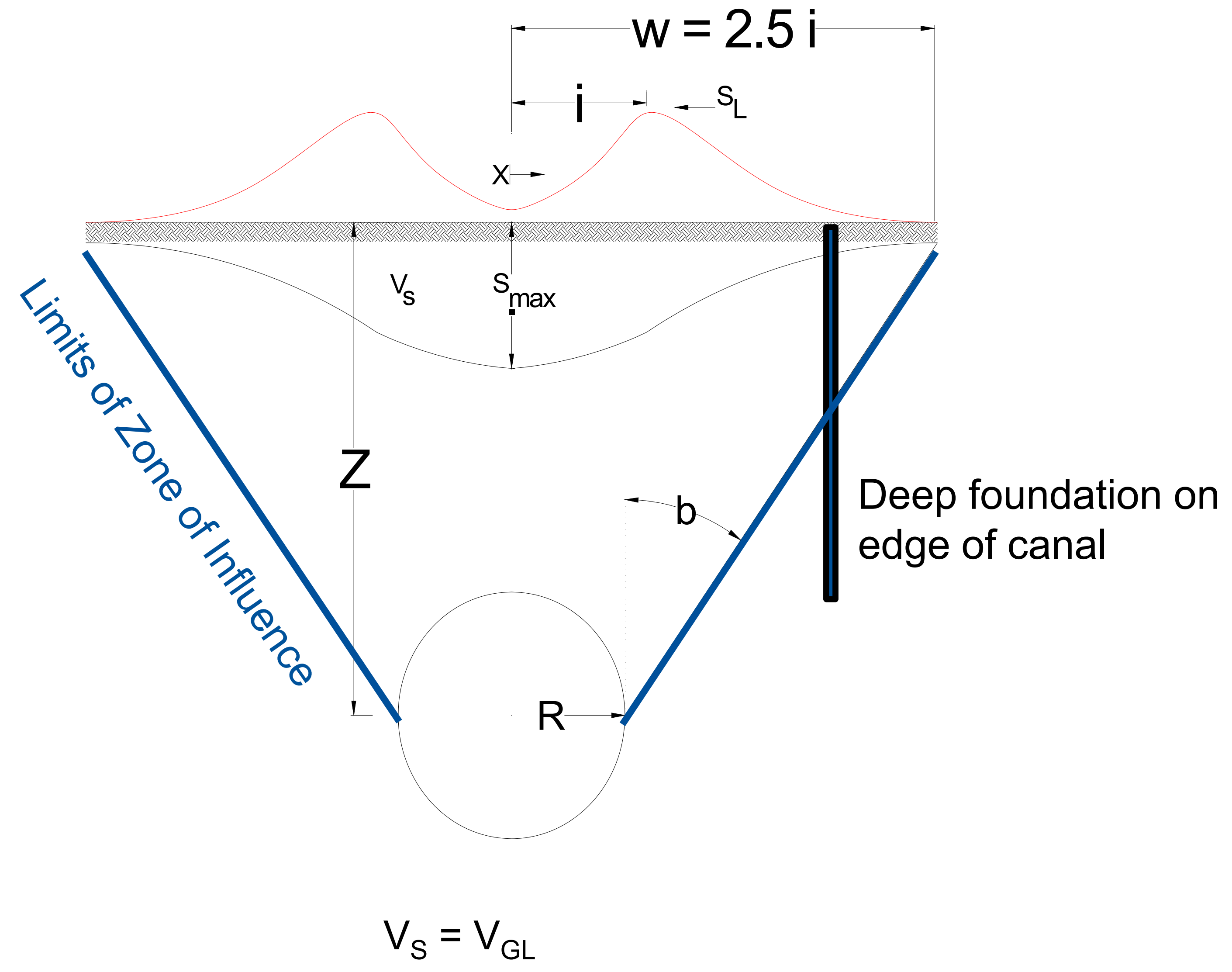
Construction Considerations: Settlement Mitigation

Selected alignment is not directly beneath any deep foundations except for the National Grid Barrier Wall.

Image shows typical shape of Zone of Influence of ground movements above a tunnel. Deep foundations on the edge of the canal would have tips below zone of influence as shown schematically.

Movements beneath the National Grid wall will likely be less than those cause by the tank construction and localized directly over the tunnel.

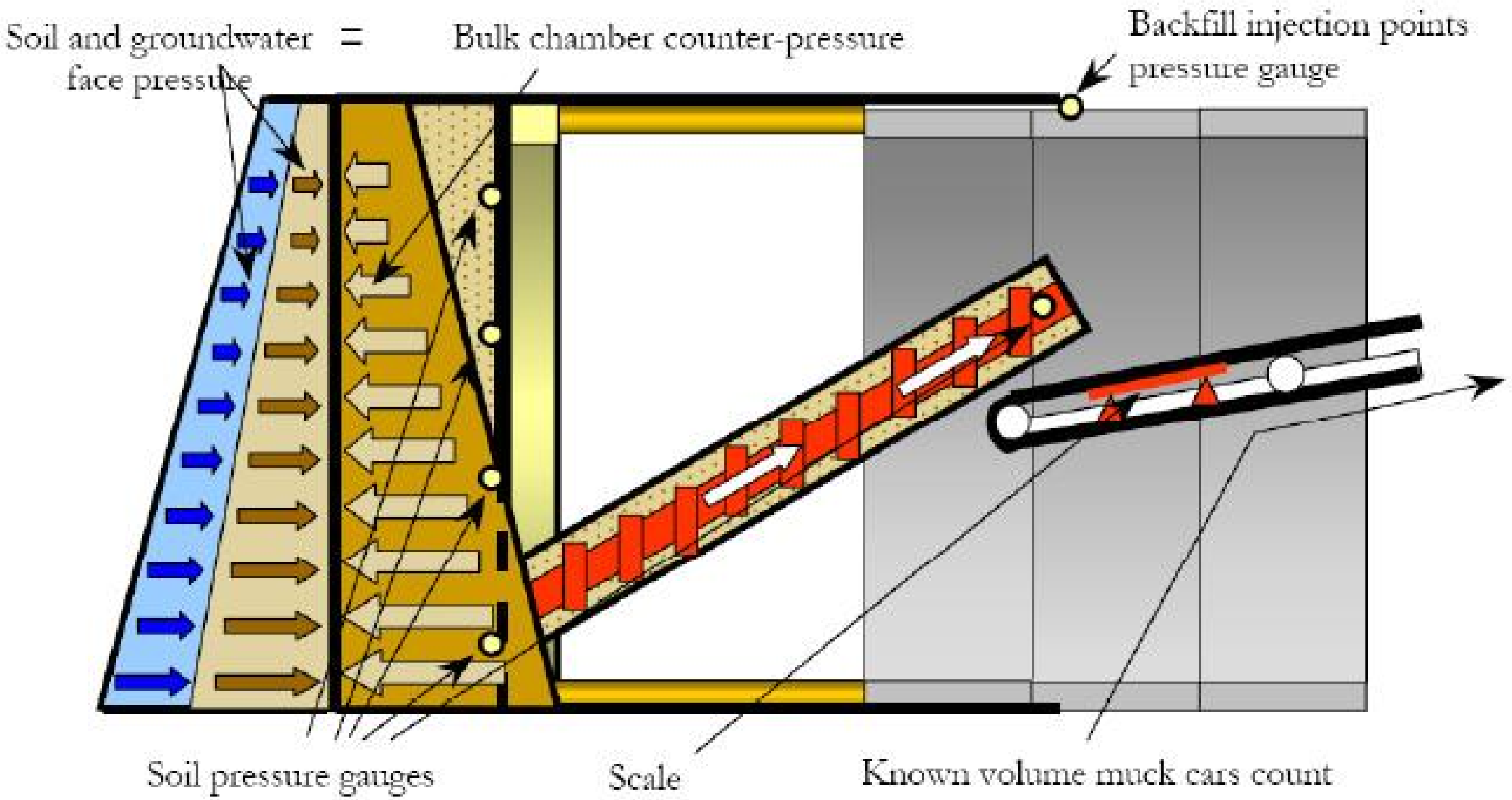
Very preliminary estimates of ground movements at the surface and at a depth corresponding to the toe of the barrier wall show that ground movements from the tunnel will be low in magnitude (0.5 inches or less), which should not have an impact on a cap comprised of flexible material (clay).



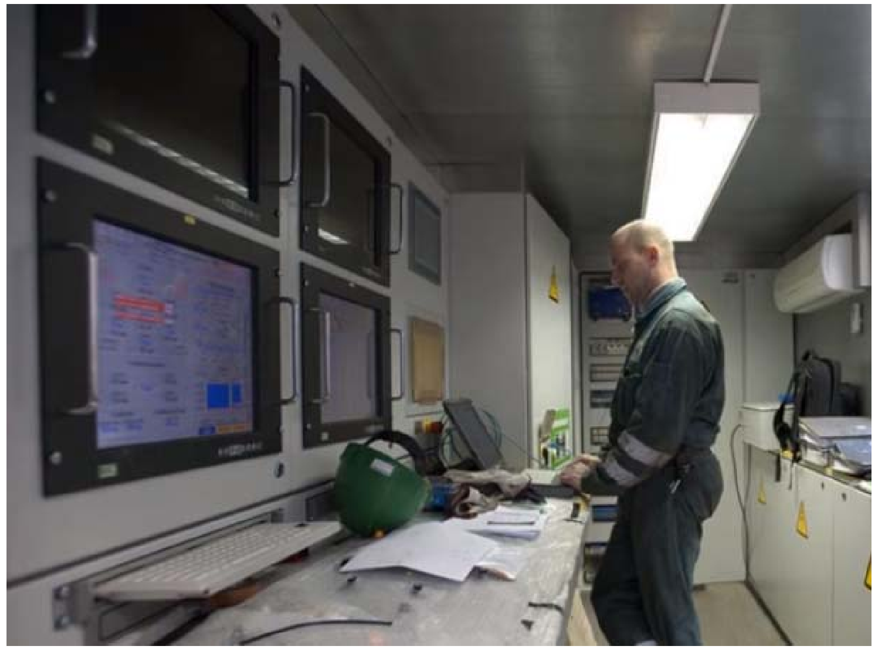
Construction Considerations: Settlement Mitigation

Measures for TBM face and crown stability control:

- Pressure sensors
- Precise measurements of extracted material
- Conditioning of soil with foam/slurry injection
- Data logged and reviewed in real time



Robbins TBM Manufacturer, Foam Test



Machine Operator Monitoring Process Data

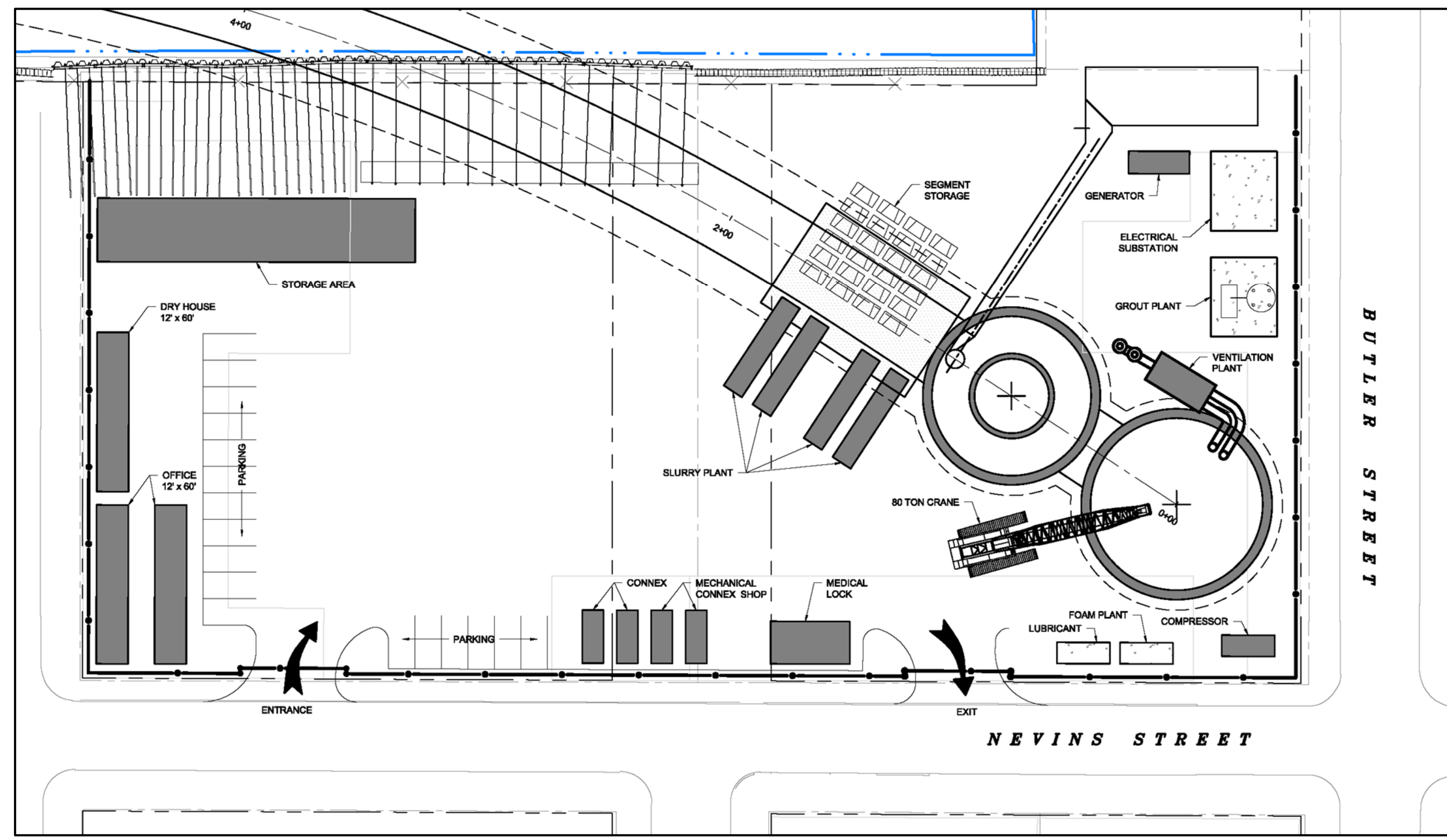
Environmental Protection

Tunnel staging requires a smaller footprint than tank construction staging.

Tunnel production work is within the below-ground tunnel except for spoil removal and liner delivery.

Additional provisions can be made to limit construction impacts on the surface.

Example: 2nd Avenue Subway Muck Transfer Shed



Generalized Construction Staging Configuration

Design Flexibility for Head End Site

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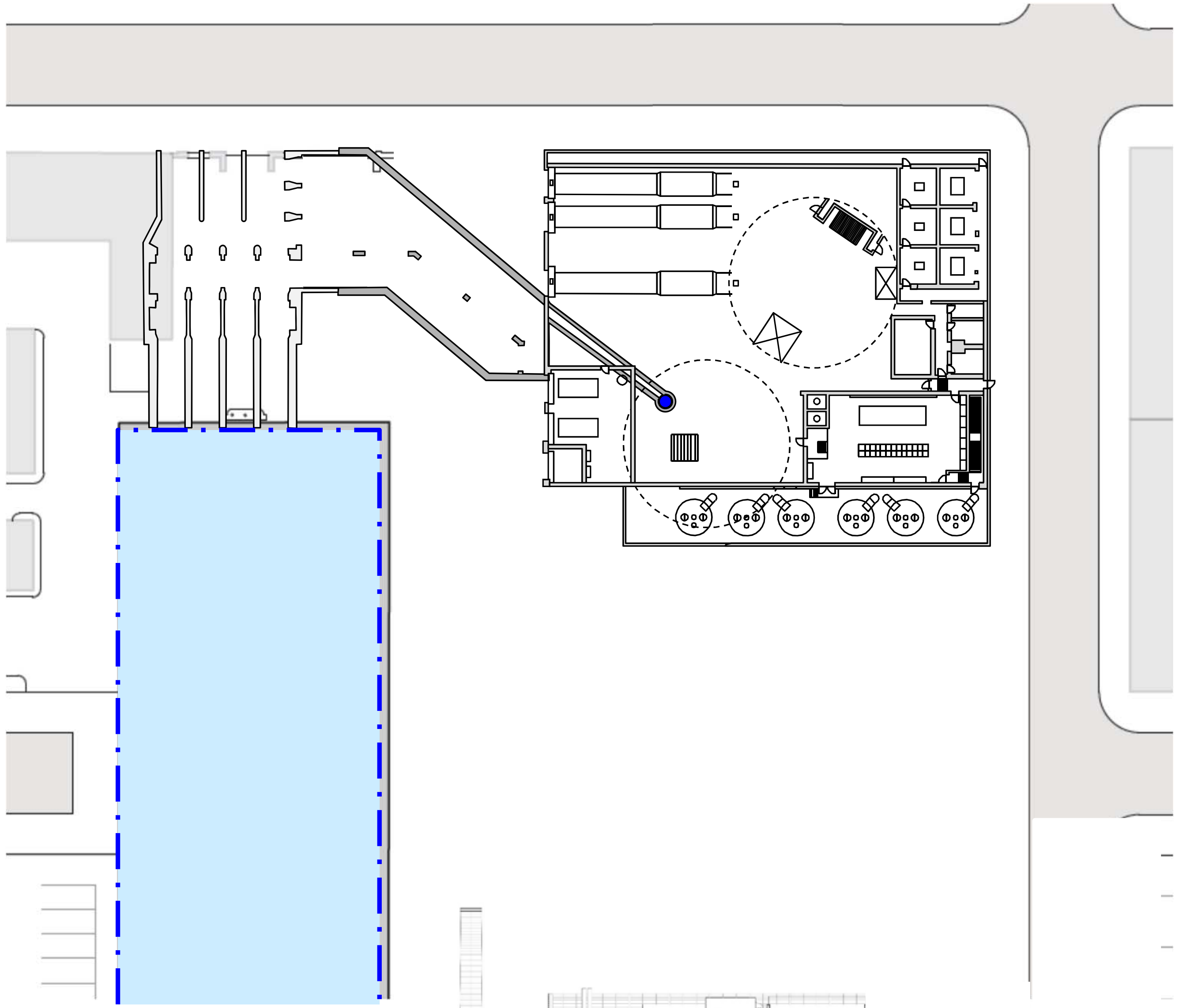
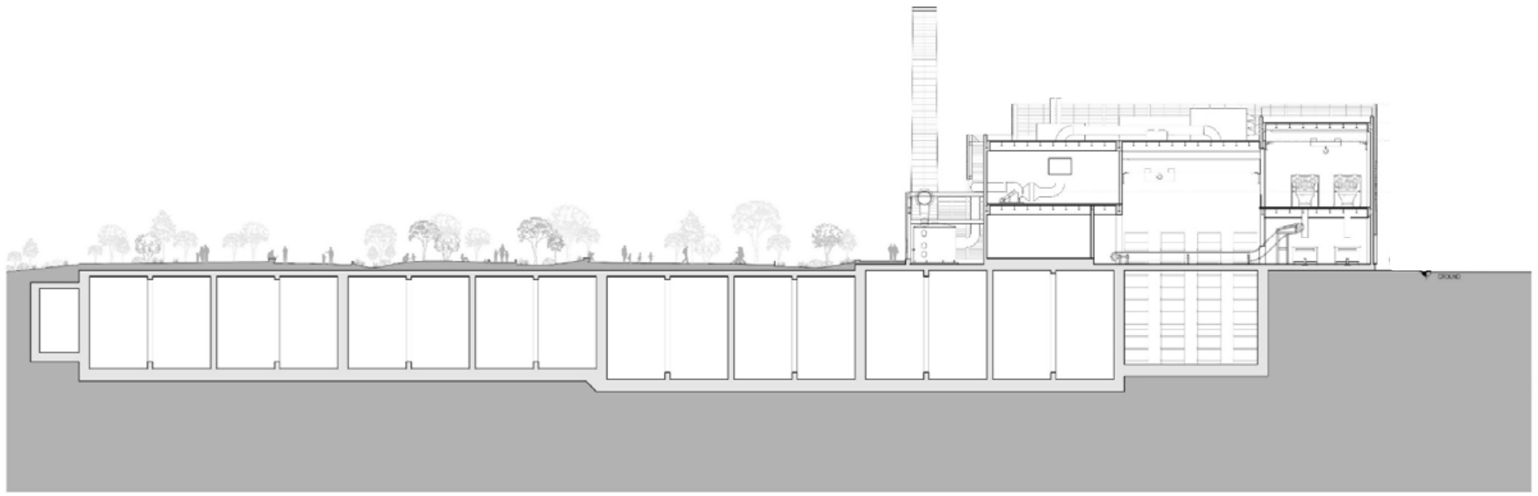
Footprint of the headhouse is expected to be comparable to provide screens, degritters, pumps, odor control, mechanical and electrical equipment.

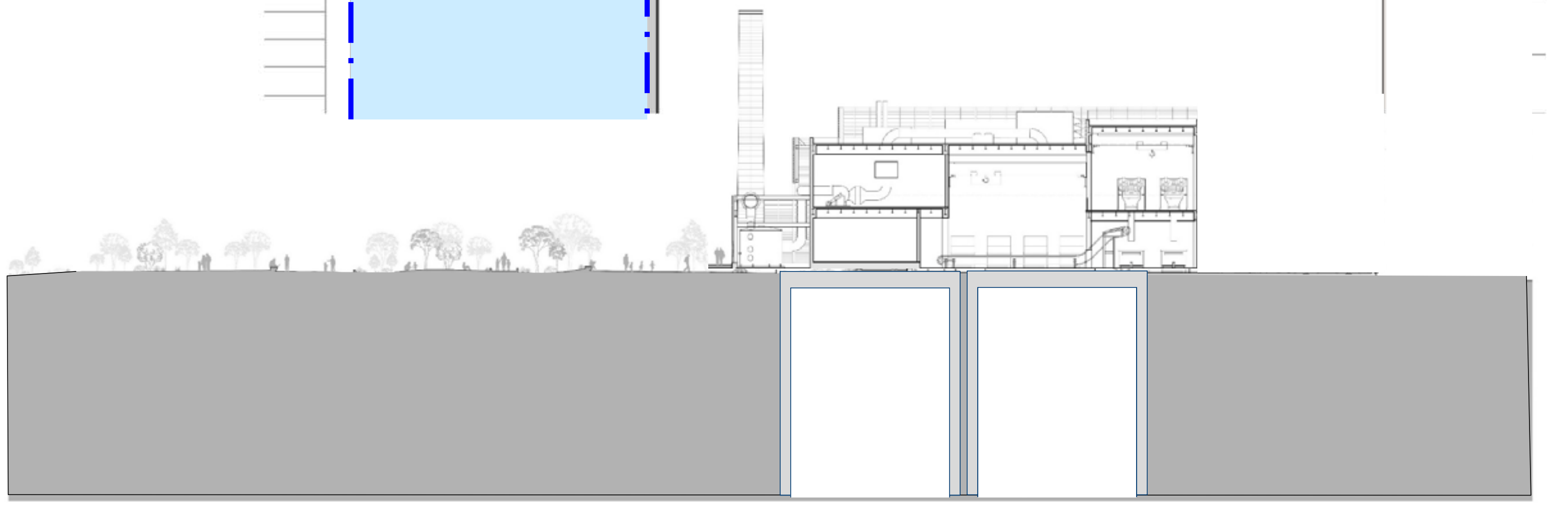
Without the tanks extending south below ground, there is much more flexibility in the design of the public open space, including less operational considerations and increased soil volumes for more tree planting.

There is also potential to shift the shafts and headhouse southward without impacting operational efficiency.





Tank Program



Tunnel Program

Cost Comparison

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Phase	Tanks ($M)	Tunnel ($M)
Facility Planning & Design	120	100
Construction Management	83	100
Acquisition	190	190
Construction	800	860
Total	**1,193**	**1,250**

Schedule Comparison

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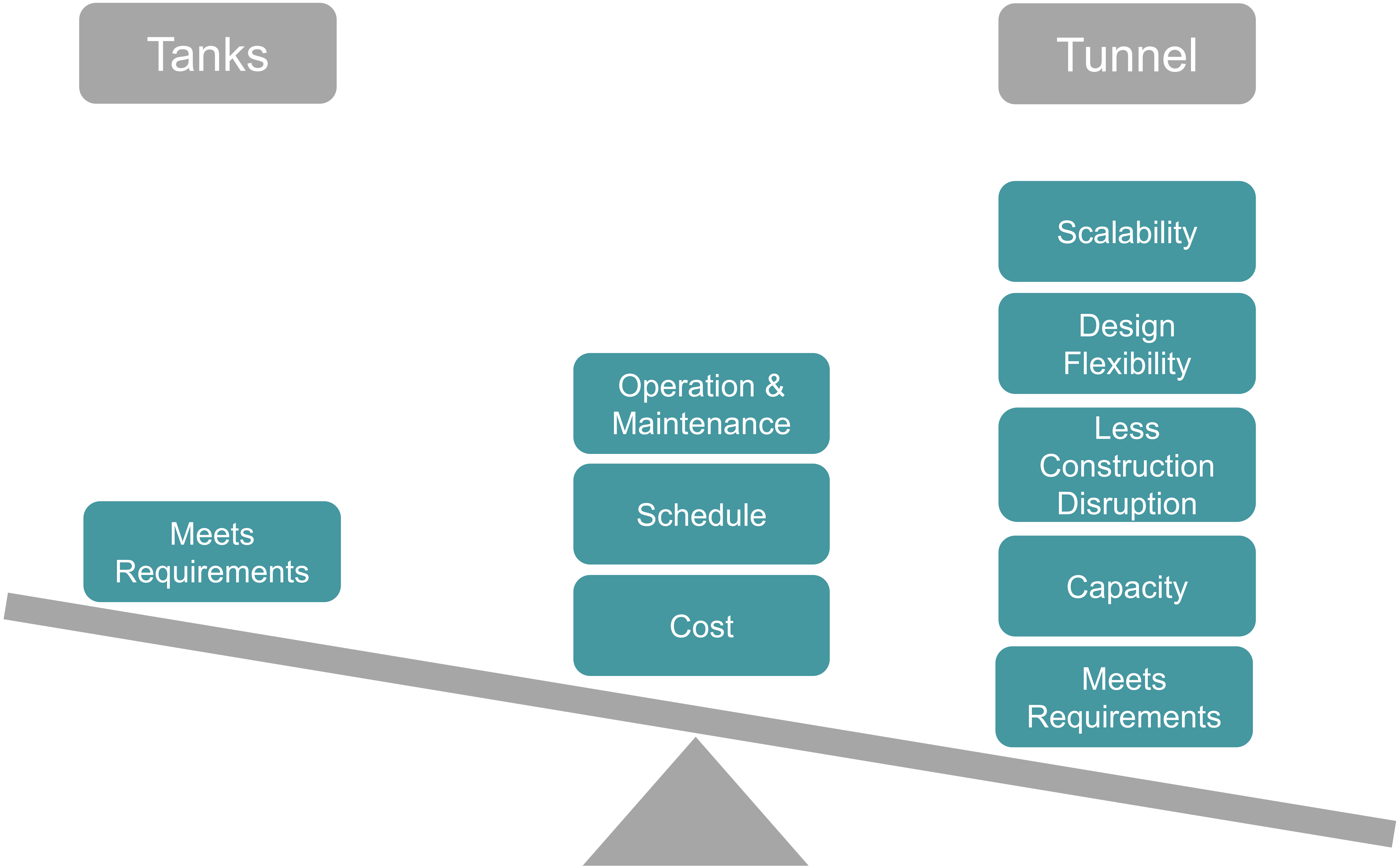
Phase	Head End Tank (current)*	Owls Head Tank (current)	Tunnel (proposed)
Facility Planning & Design	Feb 2014 - Sept 2019	Jan 2020 - July 2023	Jan 2020 - Jan 2024
Site Prep & Demo	July 2019 - July 2020	July 2021 - July 2023	1 year duration between 2020-2023 (flexible**)
Excavation & Superstructure	July 2022 - Nov 2029	July 2023 - **July 2030**	Jan 2025 - **Dec 2030**
Future Phases	N/A	N/A	TBD

*Head End Tank schedule subject to delay pending resolution of building preservation issue

**To be coordinated with National Grid cleanup

Recap: Comparison of Benefits



Next Steps

- DEP continues to advance the tank design to meet all EPA milestones
- DEP procure a new contract for detailed planning and design (12 months)
- DEP continues public outreach
- DEP / EPA continue Technical / Schedule discussions
- EPA evaluates if the tunnel alternative is acceptable

Questions?

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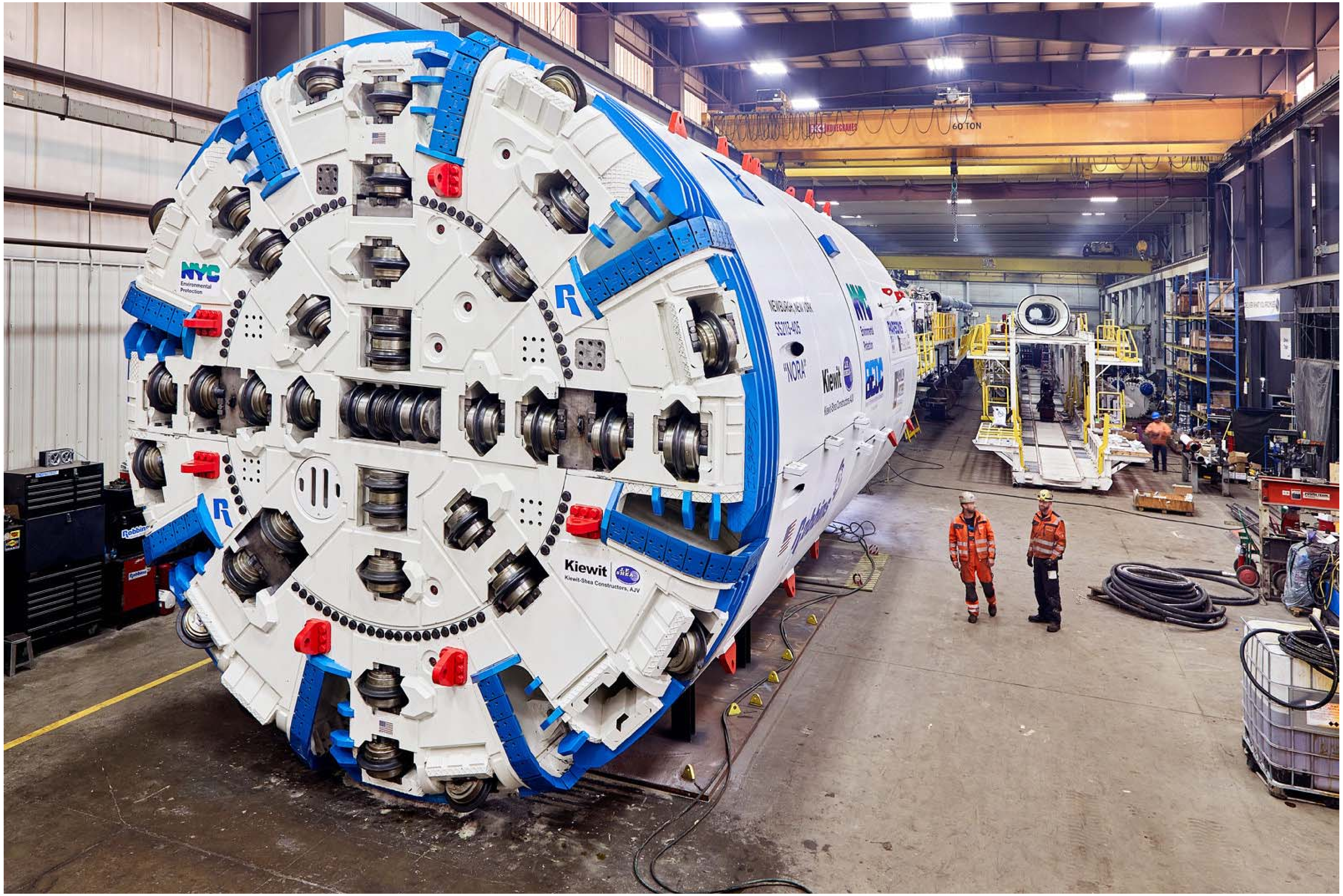

“Nora,” DEP’s TBM for the Delaware Aqueduct Bypass Tunnel, photo courtesy of The Robbins Company